HIGHLIGHTED ARTICLES

North Atlantic right whale foraging ecology and its role in human caused mortality the Channel Islands Region
Marine Ecology Progress Series (2.54)

An Economic Analysis of Shipping Costs Related to Potential Measures to Manage the Co-Occurrence of Maritime Vessel Traffic and Whales in the Channel Islands Region
NOAA Tech Memo (N/A)

Incidence of disturbance and damage to deep-sea corals and sponges in areas of high trawl bycatch near the California and Oregon border
Deep-Sea Research II (1.713)

Phenological and distributional shifts in ichthyoplankton associated with recent warming in the northeast Pacific Ocean
Global Change Biology (8.502)

Comparing apples to oranges: Common trends in anthropogenic and environmental pressures across multiple marine ecosystems
Frontiers in Marine Science (N/A)

CROSS LINE OFFICE ARTICLES

Engaging with users of climate information and the co-production of knowledge
Weather Climate and Society (2.594)

ADDITIONAL ARTICLES

NMFS Publications

Age, growth, mortality and reproductive seasonality of jolthead porgy, *Calamus bajonado*, from Florida waters
PeerJ (2.183)

Impacts of ocean-climate variability on biodiversity of pelagic forage species in an upwelling ecosystem
Marine Ecology Progress Series (2.361)

A resonant response of the California Current circulation to forcing by low frequency climate variability
Deep-Sea Research II (2.85)

Genetic fingerprinting reveals natal origins of male leatherback turtles encountered in the Atlantic Ocean and Mediterranean Sea
Marine Biology (2.136)

Trophic ecology of green turtle *Chelonia mydas* juveniles in the Colombian Pacific
Journal of the Marine Biological Association of the UK (1.07)

Opportunism on the high seas: foraging ecology of olive ridley turtles in the eastern Pacific Ocean
Frontiers in Marine Science (N/A)

Resource partitioning facilitates coexistence in sympatric cetaceans in the California Current
Ecology and Evolution (2.44)

HIGHLIGHTED ARTICLES

North Atlantic right whale foraging ecology and its role in human caused mortality
Marine Ecology Progress Series (2.54)
M. F. Baumgartner, **F.W. Wenzel (NMFS/NEFSC),** N.S.J. Lysiak, M.R. Patrician

- Diving and foraging behavior plays an unknown role in mediating human-caused mortality.
- Diving behavior of the tagged whales was governed by the vertical distribution of their primary prey.
- Relatively high incidence of near-bottom diving raises serious concerns about the continued use of floating ground lines in pot and trap gear in coastal Maine and Canadian waters.

Endangered North Atlantic right whales suffer from unacceptably high rates of ship strikes and fishing gear entanglements, but little is known of the role that diving and foraging behavior plays in mediating human-caused mortality. We conducted a study of right whale foraging ecology by attaching tags to whales for short periods of time (hours), tracking their movements during daytime, and repeatedly sampling oceanographic conditions and prey distribution along the whales' tracks. Right whales were tagged from late winter to late fall in 6 regions of the Gulf of Maine and southwestern Scotian Shelf from 2000 to 2010. The diving behavior of the tagged whales was governed by the vertical distribution of their primary prey, the copepod Calanus finmarchicus. On average, right whales tagged during spring spent 72% of their time in the upper 10 m (within the draft of most large commercial vessels), indicating the need for expanded ship speed restrictions in western Gulf of Maine springtime habitats. One out of every 4 whales dove to within 5 m of the sea floor during the short time they were tagged, spending as much as 45% of their total tagged time in this depth stratum. Right whales dove to the sea floor in each habitat studied except for one (where only 1 whale was tagged). This relatively high incidence of near-bottom diving raises serious concerns about the continued use of floating ground lines in pot and trap gear in coastal Maine and Canadian waters.

Acceptance date: August 23, 2017

An Economic Analysis of Shipping Costs Related to Potential Measures to Manage the Co-Occurrence of Maritime Vessel Traffic and Whales in the Channel Islands Region

NOAA Tech Memo (N/A)

S. B. Gonyo (NOS/NCCOS/MSED), T. L. Goedeke (NOS/NCCOS), K. E. Wolfe (NOS/ASTADM), C. F. G. Jeffrey (NOS/NCCOS/MSED), M. Gorstein (NOS/NCCOS), M. Poti (NOS/NCCOS), D. S. Dorfman (NOS/NCCOS)

- The total costs to the LA/LB Port District shipping industry are predicted to decrease under the potential management measures with vessel re-routing and increase under the seasonal VSR only measures. However, none of these predicted changes are significant and they only represent a 0.1% to 0.6% change in total vessel operating costs on a hypothetical Hong Kong to LA/LB Port District transit and 0.0002% to 0.0004% of LA/LB Port District's cargo value.
- These results will provide additional information to CINMS to determine the feasibility of the analyzed potential management measures. Additionally, this study provides a framework for similar work in other regions.

The Channel Islands region off the coast of southern California provides habitat to prominent populations of blue, fin, humpback, and gray whales. It is also home to the nation's two business ports: Long Beach and Los Angeles. As ocean going vessels have become more numerous, larger, and faster, the frequency of vessels striking whales, as well as the force and severity with which vessels strike whales, has increased. The objective of this report is to assess for Channel Islands National Marine Sanctuary (CINMS) and other agencies the economic effects of five potential management measures through a shipping cost and pollution emissions analysis. The total costs to the LA/LB Port Complex shipping industry are not predicted to change significantly under any of the potential management measures. Additionally, the changes only represent a 0.1% to 0.6% change in total vessel operating costs on a hypothetical Hong Kong to LA/LB Port District transit and 0.0002% to 0.0004% of LA/LB Port District's cargo value.

Expected publication date: October 2017

Incidence of disturbance and damage to deep-sea corals and sponges in areas of high trawl bycatch near the California and Oregon border

Deep-Sea Research II (1.713)

M. M. Yoklavich (NMFS/SWFSC), T. E. Laidig (NMFS/SWFSC), K. Graiff (NOAA Cordell Bank Sanctuary), M. E. Clarke (NMFS/NWFSC), C. E. Whitmire (NMFS/NWFSC)

- This is the first assessment of the extent of mechanical damage to corals and sponges in deep water in areas of high trawl effort on the west coast.
- Results from this study establish a baseline to evaluate recovery of corals and sponges, and to assess restoration of the community structure and associated functions of corals and sponges

We evaluated disturbance and damage to deep-sea corals and sponges (DSCS) in areas of longtime (>65 years) bottom trawling off southern Oregon and northern California. The incidence of disturbance was quantified from video and still images collected along strip transects conducted with underwater vehicles operating at depths of 600-2,100 m. All DSCS were identified, counted, and measured, condition (healthy, unhealthy, or dead) was determined, and associated seafloor substratum types were designated. Physical disturbance and damage were classified as DSCS with broken or missing parts, overturned, or detached from the seafloor. Overall frequency of disturbance to DSCS throughout the study area was 2% of the total number observed; most of these were coral colonies while sponges were rarely damaged. There was notable disturbance to corals, particularly to bamboo corals of the family Isididae (45% of 873 colonies were impacted), at depths of 1100-1150 m in our most northern study site off southern Oregon and the southern site off Cape Mendocino, California. Nearly 20% (n=78) of disturbed bamboo corals were sheared off at the base, leaving only small stumps to be counted. Height of intact undisturbed bamboo coral colonies ranged from 5 to 185 cm. The Mendocino Ridge area had the highest incidence of coral bycatch in research bottom trawls conducted between 2001 and 2015. Using visual survey tools, we now have a better understanding of the extent of damage and disturbance to DSCS. Conservation areas have been implemented off the U.S. West Coast to protect seafloor habitats, but DSCS in our study site remain vulnerable to impacts from bottom-contact fishing gears.

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Phenological and distributional shifts in ichthyoplankton associated with recent warming in the northeast Pacific Ocean

Global Change Biology (8.502)

T. D. Auth, E. A. Daly, **R. D. Brodeur**, **J. L. Fisher(NMFS/NWFSC)**

- The California Current is seeing dramatic rippling effects of the large-scale warming event at all trophic levels and we document substantial changes in a key trophic link in the ecosystem.
- We document the northward movement of the spawning areas for major fisheries resources that could be a manifestation of a new ecological state and community reorganization in this highly productive ecosystem.
- there have been unprecedented shifts in spawning phenology and habitats related to major oceanographic heat wave and that fish species may be able to alter their reproductive ability to adapt to changing ocean conditions resulting from this recent warming

Predicting changes in the migratory and reproductive phenology of pelagic fish stocks in the California current in relation to climate change is needed for accurate ecosystem-based fisheries management plans. Relocation and changes in timing of reproduction can have dramatic effects upon the success of pelagic fish populations and throughout the food web. During anomalously warm conditions (1-4º C above normal) in the northeastern Pacific Ocean from late 2014 through 2016, we documented both timing and spawning location shifts in several pelagic fish stocks based on larval fish samples. The total larval concentrations in winter (January-March) 2015 and 2016 were the highest since annual collections first occurred in 1998 in the northern California Current (NCC), due to high amounts of larval *Engraulis mordax* (northern anchovy) and *Sardinops sagax* (Pacific sardine), which are normally summer spawning species in the region. Pacific sardine historically spawn south of the NCC region, but exhibited an early and northward spawning expansion in 2015-16. Additionally, spawning duration was greatly increased for *E. mordax* as the presence of larvae was observed throughout the

majority of 2015-16, indicating nearly continuous spawning of adults throughout the warm period. A third species, *Merluccius productus* (Pacific hake), also demonstrated an early and northward shift in their spawning distribution since they normally spawn off southern California during winter and spring. Larvae from all three of these species have never before been collected in the NCC as early in the year. These findings suggest that the spawning phenology and distribution of several ecologically and commercially important fish species in the NCC dramatically and rapidly changed in response to the warming conditions occurring in 2014-2016, and could be an indication of future conditions under projected climate change.
Acceptance date: August 8, 2017

Comparing apples to oranges: Common trends in anthropogenic and environmental pressures across multiple marine ecosystems
Frontiers in Marine Science (N/A)
J. Tam (NMFS/NEFSC), **J. S. Link (NMFS/NEFSC)**, S. I. Large, **K. S. Andrews (NMFS/NWFSC)**, **K. D. Friedland (NMFS/NEFSC)**, **J. Gove (NMFS/PIFSC)**, **E. L. Hazen (NMFS/SWFSC)**, **K. K. Holsman (NMFS/AKFSC)**, **M. Karnauskas (NMFS/SEFSC)**, **J. F. Samhouri (NMFS/NWFSC)**, **R. Shuford (NMFS/OST)**, **N. Tolimieri (NMFS/NWFSC)**, **S. Zador (NMFS/AKFSC)**

- Ecosystem based management (EBM) is partially reliant on cological indicators that facilitate understanding of inherent properties and the dynamics of pressures within marine communities.
- Thresholds were developed using gradient forest for a suite of ecological indicators in response to multiple pressures that convey ecosystem status for large marine ecosystems.
- Comparison of results across multiple large marine ecosystems reveal common trends in ecosystem thresholds along pressure gradients and also indicate that thresholds of ecological indicators are useful tools for comparing the impacts of environmental and anthropogenic pressures across multiple ecosystems.

Ecosystem-based management (EBM) in marine ecosystems considers impacts caused by complex interactions between environmental and anthropogenic pressures (i.e. oceanographic, climatic, socio-economic) and marine communities. EBM depends, in part, on ecological indicators that facilitate understanding of inherent properties and the dynamics of pressures within marine communities. Thresholds of ecological indicators delineate ecosystem status because they represent points at which a small increase in one or many pressure variables results in an abrupt change of ecosystem responses. The difficulty in developing appropriate thresholds and reference points for EBM lies in the multidimensionality of both the ecosystem responses and the pressures impacting the ecosystem. Here, we develop thresholds using gradient forest for a suite of ecological indicators in response to multiple pressures that convey ecosystem status for large marine ecosystems from the US Pacific, Atlantic, sub-Arctic, and Gulf of Mexico. We detected these thresholds of ecological indicators based on multiple pressures. Commercial fisheries landings above approximately 2-4.5 t km-2 and fisheries exploitation above 20-40% of the total estimated biomass (of invertebrates and fish) of the ecosystem resulted in a change in the direction of ecosystem structure and functioning in the ecosystems examined. Our comparative findings reveal common trends in ecosystem thresholds along pressure gradients and also indicate that thresholds of ecological indicators are useful tools for comparing the impacts of environmental and anthropogenic pressures across multiple ecosystems. These critical points can be used to inform the development of EBM decision criteria.

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http://journal.frontiersin.org/article/10.3389/fmars.2017.00282/full

CROSS LINE OFFICE ARTICLES

Engaging with users of climate information and the co-production of knowledge
Weather Climate and Society (2.594)
M. C. Kruk (NESIDS/NCEI), B. Parker (NOS/OCM), J. Marra (NESDIS/NCEI), K. Werner (NMFS/NWFSC), R. Heim (NESDIS/NCEI), R. Vose (NESDIS/NCEI), and P. Malsale

- Interactions with decision makers should be made more deliberate to improve understanding of decision points and what climate data or services might be applicable.
- Workshops and dialogs should be less focused on the presentation of science, instead engaging with participants in relating major climate and weather events to local-scale impacts. This interaction can be used to inform the user community on existing climate information and products that may be applied to future analogous weather and climate events.
- Maximizing interaction and learning both ways is essential, whether through facilitated discussions, or other facilitator tools such as small group work, voting, use of colored dots, etc. This signals that the workshop hosts are eager to learn from the attendees, which in turn can encourage attendees to be more outspoken and contributory to the overall objectives of the workshop.

Within the realm of climate and environmental sciences, stakeholder engagement has traditionally been given a relative low priority in favor of generating tools, products, and services following the longstanding practice of pushing out information in the hopes users will pull it into their decision toolkits. However, the landscape is gradually shifting away from that paradigm and towards one in which the stakeholder community is more directly involved in the production of products and services with the scientific organization. This mutual learning arrangement, referred to as the co-production of knowledge, has been applied to two user-engagement activities within the National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information (NCEI) and the NOAA Office of Coastal Management Coral Reef Conservation Program (CRCP). The iterative nature of such dialogs helped scientists within NCEI and

OCM to better understand user requirements and as a result generate climate information that was locally relevant and regionally applicable. The recent engagement activities exemplified the benefits of a robust and sustained relationship between climate scientists and the user community. They demonstrate that the interactions between the two led to the empowerment of the local community to shape and mold climate information products, as well as further enhancing user buy-in of these products and services with which local agriculture and food security, disaster risk reduction, energy, health, and water decisions are being made. This co-production of knowledge model for user-engagement activities also serves to build trust between the scientific and user communities.
Publication date: August 18, 2017
Available online: http://journals.ametsoc.org/doi/abs/10.1175/WCAS-D-16-0127.1

NMFS Publications

Age, growth, mortality and reproductive seasonality of jolthead porgy, Calamus bajonado*, from Florida waters*
PeerJ (2.183)
M. L. Burton, J. C. Potts, J. Page, A. Poholek (NMFS, SEFSC)

- This is the first published scientific information on life history parameters of this species from U. S. waters, in response to a fishery closure three years ago due to the ACL being exceeded.

Ages of jolthead porgy (*Calamus bajonado* Schneider 1801) (n = 635) from Florida commercial and recreational fisheries from 2008 – 2016 were determined using sectioned sagittal otoliths. We determined, using edge-type analysis, that opaque zones were annular, forming March – June (peaking in April). Jolthead porgy ranged from 1 – 13 years, and the largest fish measured 680 mm TL (total length, mm). Body size relationships for jolthead porgy were TL = 1.09 FL + 20.44 (n = 622, r^2 = 0.99), FL = 0.90 TL – 14.26 (n= 622, r^2 = 0.99), and W = 1.1 x 10^{-5} $TL^{3.06}$ (n = 577), where W is total weight (grams, g) and FL is fork length (mm). The von Bertalanffy growth equation for jolthead porgy was $L_t = 737\ (1 - e^{-0.14\ (t + 2.02)})$ (n = 635). Point estimate of natural mortality was M = 0.32, while age-specific estimates of M ranged from 0.58 – 0.17 y^{-1} for ages 1– 13. Catch curve analysis

estimated the instantaneous rate of total mortality $Z = 0.70$, while instantaneous rate of fishing mortality F was 0.38. Macroscopic staging of female gonads indicated the presence of hydrated oocytes from December – March, and GSI data indicates that peak spawning in females occurs during March. This study presents the first published findings of life history parameters for jolthead porgy from the Atlantic waters off the southeastern United States.
Publication date: September 8, 2017
Available online: https://peerj.com/articles/3774/

Impacts of ocean-climate variability on biodiversity of pelagic forage species in an upwelling ecosystem
Marine Ecology Progress Series (2.361)
J. Santora (UCSC/SWFSC), E. Hazen (NMFS/SWFSC), I. Schroeder (UCSC/SWFSC), S. Bograd (NMFS/SWFSC), K. Sakuma (NMFS/SWFSC), J. Field (NMFS/SWFSC)

- Provides a summary of diversity trends in the pelagic micronekton assemblage and example application of how diversity metrics can function as ecosystem indicators.
- Includes the somewhat counterintuitive result that high diversity levels may not always correlate with optimum ecosystem state or productivity conditions.

Monitoring essential marine biodiversity variables is an effective means for assessing impacts of climate change and human-related stressors such as pollution, overfishing, and habitat destruction. Yet little is known about the natural variability of biodiversity in pelagic upwelling marine ecosystems, which are often subject to substantial inter-annual and decadal variability of ocean-climate conditions. Using data from a pelagic midwater trawl survey, we quantified diversity indices of epipelagic forage species collected over 26 years (1990-2015) to determine the natural variability and environmental determinants of biodiversity within the California Current upwelling ecosystem. Biodiversity time series indicate there are two alternate forage species assemblages that relate to differences in cool/strong and warm/weak upwelling years that vary in 3-5 year cycles. Cooler years are associated with increased biodiversity of juvenile groundfish, whereas warm years

coincide with increased biodiversity of coastal and mesopelagic fishes and species originating from southern and sub-tropical waters. During 2015, a year of anomalous warm surface-ocean conditions, we observed unprecedented high levels of biodiversity and attribute it to high abundance of juvenile groundfish combined with an unusually high transport of sub-tropical and offshore species into neritic waters. Using a combination of remote-sensing and in situ hydrographic data, we compare 2015 to previous anomalous ocean-climate conditions and discuss how biodiversity of forage species may impact trophodynamics of upwelling ecosystems and predator-prey interactions. Attributing changes in marine biodiversity to productivity cycles and anomalous climate events, and detecting long-term biodiversity trends, provides a critical index towards understanding climate forcing on upwelling ecosystems.
Acceptance date: July 26, 2017

Opportunism on the high seas: foraging ecology of olive ridley turtles in the eastern Pacific Ocean
Frontiers in Marine Science (N/A)
L. E. Peavey, B.N. Popp, **R.L. Pitman**, S.D. Gaines, K.E. Arthur, S. Kelez, and **J.A. Seminoff (NMFS/SWFSC)**

- The study describes the trophic ecology of olive ridley sea turtles when they are in the open ocean and estimated trophic position of adults using amino acid compound specific isotope analysis.
- Results found that that trophic position does not vary across age or sex, and trophic position only slightly varies among regions, with the trophic position of olive ridleys in Costa Rica being slightly higher than turtles in other regions.

Stable isotopic compositions in animal tissues have been widely used to gain insight into trophic dynamics, especially of mobile aquatic predators whose behavior and dietary preferences are difficult to directly measure. Olive ridley sea turtles (*Lepidochelys olivacea*) range across >3 million km^2 of the tropical and subtropical eastern Pacific Ocean and their trophic ecology in open ocean areas has not yet been adequately described. Individuals feed within biogeographic regions where varying nutrient cycling regimes result in phytoplankton with distinct δ13C

and δ15N values that are assimilated by the turtles. We sampled 346 turtles at sea between 2003 and 2009 and used bulk tissue (n = 346) and amino acid compound specific isotope analysis (AA-CSIA, n = 31) to empirically support the conventional understanding that olive ridleys are omnivores. Bulk δ15N values did not significantly vary with carapace length, a proxy for age, or with putative gender of adults. We therefore hypothesize that trophic position (TP) does not vary across age or sex. In line with other isotopic studies of this biogeographic scale in the same region, we observed a trend of bulk tissue 15N enrichment with increasing latitude. Using AA-CSIA to account for δ15N baseline shifts among food webs (space), we estimated the TP of adult foragers. We found that across their eastern Pacific range, olive ridley niche area varied but median TP of adults remained constant (~3.1). Using the simpler of two TP estimation methods, we detected a small but notable elevation of TP for olive ridleys in the Costa Rica Dome only. This study underscores the value of large-scale in-water olive ridley sea turtle research across oceanic foraging habitats to confirm or challenge anecdotal understanding of trophic roles, susceptibility to environmental change, and critical habitats. Further, it improves our understanding of why this species is now abundant in the eastern Pacific Ocean. A prey generalist with plenty of suitable foraging habitat can recover from the brink of extinction despite the presence of major threats. However, such foraging characteristics may require dynamic open ocean management approaches to meet conservation objectives as threats persist and/or increase.
Acceptance date: August 7, 2017

A resonant response of the California Current circulation to forcing by low frequency climate variability
Deep-Sea Research II (2.85)
W. Crawford, A. Moore, **M. Jacox (NMFS/SWFSC-ERD)**, J. Fiechter, E. Neveu, C. Edwards

- Climate variability excites oscillations in the California Current System with various frequencies, especially in the 4-10 year range
- These oscillations have specific signatures in the physical ocean environment, and likely force oscillations in biological communities as well

Low frequency variability of the California Current System (CCS) is investigated using circulation estimates based on a 31-year (1980-2010) sequence of historical analyses of the CCS calculated using the Regional Ocean Modeling System (ROMS) 4-dimensional variational (4D-Var) data assimilation system. The leading 3-dimensional multivariate empirical orthogonal functions (3D EOFs) of the CCS circulation were computed and provide a detailed view of low-frequency circulation variability within the CCS. The 3D EOFs are used as basis functions for a linear inverse model of the circulation, and several Principal Oscillation Patterns (POPs) of the circulation are identified. The leading POPs have periods in the range ~4-10 years, and shed light on the 3-dimensional time evolving structure associated with low-frequency variability in the circulation. A particular focus here is coastal upwelling. In particular, a POP with a period close to 10 years appears to be preferentially excited as a resonant response to forcing associated with the regional expression of the Pacific Decadal Oscillation, the North Pacific Gyre Oscillation and the El Niño Southern Oscillation.
Acceptance date: July 2017

Genetic fingerprinting reveals natal origins of male leatherback turtles encountered in the Atlantic Ocean and Mediterranean Sea
Marine Biology (2.136)
S. E. Roden (NMFS/SWFSC), **K. R. Stewart (NMFS/SWFSC)**, M. C. James, **K. L. Dodge (NMFS/NEFSC)**, F. Dell'Amico, and **P. H. Dutton (NMFS/SWFSC)**

- Atlantic male leatherbacks, a highly migratory marine megafuana with unknown life history patterns, were genetically sampled from 1997-2012 to reveal nesting population origins of foraging male leatherbacks throughout the Atlantic and Mediterranean.
- The results supported 'north-south hemisphere split' model for leatherbacks foraging in Atlantic Ocean, with all turtles originating from western Atlantic nesting beaches (Trinidad, French Guiana, and Costa Rica).
- These results advance techniques and understanding of previously unknown male dispersal relevant to management and threats and provide comparative data to the more accessible females.

Understanding population dynamics in broadly distributed marine species with cryptic life history stages is challenging. Information on the population dynamics of sea turtles tends to be biased toward females due to their accessibility for study on nesting beaches. Males are encountered only at sea; there is little information about their migratory routes, residence areas, foraging zones, and population boundaries. In particular, male leatherbacks (*Dermochelys coriacea*) are quite elusive; little is known about adult and juvenile male distribution or behavior. The at-sea distribution of male turtles from different breeding populations is not known. Here, 122 captured or stranded male leatherback turtles from the USA, Turkey, France, and Canada (collected 1997-2012) were assigned to one of nine Atlantic-basin populations using genetic analysis with microsatellite DNA markers. We found that all turtles originated from western Atlantic nesting beaches (Trinidad 55%, French Guiana 31%, and Costa Rica 14%). Although genetic data for other Atlantic nesting populations were represented in the assignment analysis (St. Croix, Brazil, Florida, and Africa (west and south), none of the male leatherbacks included in this study were shown to originate from these populations. This was an unexpected result based on estimated source population sizes. One stranded turtle from Turkey was assigned to French Guiana, while others that stranded in France were from Trinidad or French Guiana breeding populations. For 12 male leatherbacks in our dataset, natal origins determined from the genetic assignment tests were compared to published satellite and flipper tag information to provide evidence of natal homing for male leatherbacks, which corroborated our genetic findings. Our focused study on male leatherback natal origins provides information not previously known for this cryptic but essential component of the breeding population. This method should provide a guideline for future studies, with the ultimate goal of improving management and conservation strategies for threatened and endangered species by taking the male component of the breeding population into account.

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Available online: https://link.springer.com/article/10.1007/s00227-017-3211-0

Trophic ecology of green turtle Chelonia mydas *juveniles in the Colombian Pacific*
Journal of the Marine Biological Association of the UK (1.07)
L. Sampson, A. Giraldo, L. F. Payán, D. F. Amorocho, M. A. Ramos, and **J. A. Seminoff (NMFS/SWFSC)**

- Diets were compared between morphotypes of juvenile green turtles from the only feeding aggregation in the Colombian Pacific.
- Food quantity, quality, and selection were estimated, with selection estimates determined through esophageal content analysis.
- No significance difference was found between the black and yellow morphotypes, and the main diet items identified for this omnivorous species were terrestrial plants, plastic fibers, invertebrates, and algae.
- This study was the first to link stable isotope analysis with gastric lavage for green turtles in the Pacific.

Gorgona National Park (GNP) protects the only known feeding aggregation of juvenile green turtles *Chelonia mydas* on the Pacific coast of Colombia. This study was undertaken to compare the diet of the two known *C. mydas* morphotypes (black and yellow), and to determine availability, selectivity, and quality of food resources at GNP. Esophageal lavages and isotopic analysis of epidermal tissue were performed on turtles captured between February and December 2012. Food quantity was estimated by determining percent cover in quadrats randomly placed on the reefs. Food quality of algae species was estimated by proximate analysis. Food selection was estimated using Ivlev´s electivity index, and the trophic level of sea turtles at GNP was calculated. A total of 30 black (mean = 63.9 cm SCL) and 47 yellow (mean = 54.3 cm SCL) morphotype turtles were lavaged. Eight invertebrate and nine algae food items were identified in esophageal contents. The most frequently found and abundant items in lavages were terrestrial plants, plastic fibers, invertebrates, and algae. A total of 27 items, including 15 algae species, were identified on the reefs, of which *Cladophora* sp. was selected by black turtles, and *Hypnea pannosa* and *Dictyota* sp. were selected by both morphotypes; the latter species had the highest protein and lipid content, and low lignin content. A trophic level of 3.5 for black and 3.4 for yellow turtles was calculated. No significant difference in diet between the two morphotypes could be determined through lavage or isotopic analysis

Publication date: August 3, 2017
Available online: https://doi.org/10.1017/S0025315417001400

Resource partitioning facilitates coexistence in sympatric cetaceans in the California Current

Ecology and Evolution (2.44)

S. Fossette, **B. Abrahms (NMFS/SWFSC), E. Hazen (NMFS/SWFSC), S. Bograd (NMFS/SWFSC)**, K. Newton, J. Calambokidis, J. Burrows, J. Goldbogen, J. Harvey, B. Marinovic, B. Tershy, D. Croll

- We investigated potential pathways that foraging behaviour may facilitate resource partitioning in two of the largest co-occurring and closely related species on Earth, blue (*Balaenoptera musculus*) and humpback (*Megaptera novaeangliae*) whales.
- Blue and humpback whales partition their foraging along three axes: qualitative (trophic), temporal, and spatial.
- Understanding the mechanisms for species coexistence is fundamental to maintaining biodiverse ecosystems, and provides insight into the evolutionary drivers of morphological differences in closely related species.

Resource partitioning is an important process driving habitat use and foraging strategies in sympatric species that potentially compete for the same limited resource. Differences in foraging behaviour are hypothesized to contribute to species coexistence by facilitating resource partitioning, but little is known on the multiple mechanisms for partitioning that may occur simultaneously. Studies are further limited in the marine environment, where the spatial and temporal distribution of resources is highly dynamic and subsequently difficult to quantify. We investigated potential pathways that foraging behaviour may facilitate resource partitioning in two of the largest co-occurring and closely related species on Earth, blue (*Balaenoptera musculus*) and humpback (*Megaptera novaeangliae*) whales. We integrated multiple long-term datasets (line-transect surveys, whale-watching records, net sampling, stable isotope analysis, and remote-sensing of oceanographic parameters) to compare the diet, phenology, and distribution of the two species during their foraging periods in the highly productive waters of Monterey Bay, California, USA within the California Current Ecosystem. Our

long-term study reveals that blue and humpback whales likely facilitate sympatry by partitioning their foraging along three axes: qualitative (trophic), temporal, and spatial. Blue whales were specialists foraging on krill, predictably targeting a seasonal peak in krill abundance, were present in the bay for an average of 4.7 months, and were spatially restricted at the continental shelf break. In contrast, humpback whales fed on a mixed diet of krill and fishes, were present in the bay for a more extended period (average of 6.6 months), and had a broader spatial distribution at the shelf break and inshore. Ultimately, the need to partition common resources can lead to morphological, physiological, and behavioural character displacement between sympatric species.

Acceptance date: July 31, 2017